

# इंटरनेट

# मानक

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“The Right to Information, The Right to Live”

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“Step Out From the Old to the New”

IS 3141 (2007): Starter Motors for internal combustion engines used for automotive and other applications [TED 11: Automotive Electrical Equipment]



“ज्ञान से एक नये भारत का निर्माण”

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Bhartrhari—Nitiśatakam

“Knowledge is such a treasure which cannot be stolen”



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भारतीय मानक

स्वचल और अन्य अनुप्रयोगों के लिए प्रयुक्त आंतरिक दहन  
इंजिन हेतु स्टार्टर मोटर — विशिष्टि

( दूसरा पुनरीक्षण )

*Indian Standard*

STARTER MOTORS FOR INTERNAL COMBUSTION  
ENGINES USED FOR AUTOMOTIVE AND OTHER  
APPLICATIONS — SPECIFICATION

( *Second Revision* )

ICS 43.060.50

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**BUREAU OF INDIAN STANDARDS**  
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG  
NEW DELHI 110002

## FOREWORD

This Indian Standard (Second Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Automotive Electrical Equipments and Instruments Sectional Committee had been approved by the Transport Engineering Division Council.

This standard was first published in 1965. It was first revised in 1983 to cover starters for all types of automotive applications and to include environmental and endurance tests. In this revision, considering developments at national and international level, new tests, namely, solenoid life test, salt spray test, thermal shock test, hot storage test, cold storage test, mud water splash test and resistance to media test have been included besides modification in test conditions

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

## *Indian Standard*

# STARTER MOTORS FOR INTERNAL COMBUSTION ENGINES USED FOR AUTOMOTIVE AND OTHER APPLICATIONS — SPECIFICATION

( *Second Revision* )

## 1 SCOPE

This standard covers the basic mechanical and electrical requirements and methods of test for 12 and 24 V dc starter motors for internal combustion engines used for automotive and other applications.

## 2 REFERENCES

The following standards contain provisions, which through reference in this text, constitute provisions of this standard. At the time of publication the editions indicated were valid. All standards are subject to revision and parties to agreements based on these standards are encouraged to investigate the possibility of applying the most recent edition of the standards indicated below:

<i>IS No.</i>	<i>Title</i>
4905 : 1968	Methods for random sampling
9000 (Part 5/ Sec 1 and 2) : 1981	Basic environmental testing procedures for electronic and electrical items: Part 5 Damp heat (cyclic) test

## 3 TERMINOLOGY

For the purpose of this standard the following definitions shall apply.

**3.1 Starter Motor** — A special dc electric motor capable of delivering high torque for short periods of time and to be used as cranking device for starting petrol/diesel/CNG/LPG engines.

**3.2 Inboard Starter Motor** — A starter motor on which the pinion moves inward towards the starter motor body to engage with the ring gear.

**3.3 Outboard Starter Motor** — A starter motor on which the pinion moves outward from the starter motor body to engage with the ring gear.

**3.4 Inertia Engagement** — Engagement effected by axial movement of the pinion along a helically splined shaft due to inertia of the pinion, when the shaft is rotated.

**3.5 Pre-engagement** — Engagement effected by

power such as solenoid before the rotation of motor.

**3.6 Axial Engagement** — Engagement effected by the sliding motion of the armature and drive assembly by the motor electromagnetic circuit before the application of full power to engine crankshaft.

**3.7 Over Running Clutch (ORC)** — A device which transmits torque from the starter motor shaft to the pinion and freewheels once the engine has started (*see* Fig. 1).

**3.8 Rated Voltage** — The voltage at which the starter motor is designed to operate.

**3.9 Lock Torque** — Torque delivered by a starter motor when connected to a rated voltage and when the pinion is restrained from rotation.

**3.10 Type Tests** — Test carried out to prove conformity with the specification. These are intended to prove the general qualities and design of a given type of starter motor.

**3.11 Acceptance Tests** — Tests carried out on each sample from a lot for the purpose of acceptance of the lot.

**3.12 Routine Tests** — Tests carried out on each starter motor to check the functional parameters, which are likely to vary during production.

**3.13 Bell-housing** — One which mounts the starter motor into the engine (*see* Fig. 2).

**3.14 Customer** — Original equipment manufacturer (OEM) of engine/vehicles.

**3.15 Supplier** — Starter motor manufacturer.

## 4 TYPE OF STARTER MOTORS

The starter motors are classified based on their capabilities to withstand various environmental and operating requirements.

### 4.1 Environmental Conditions

Starter motors are classified into the following types based on the enclosures, suitable for the environmental conditions likely to be encountered during service.

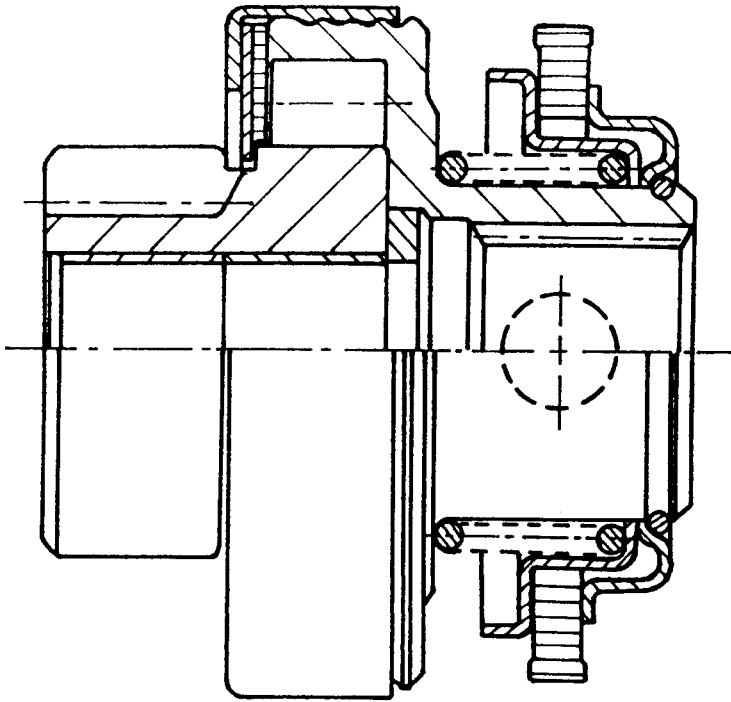


FIG. 1 OVER RUNNING CLUTCH

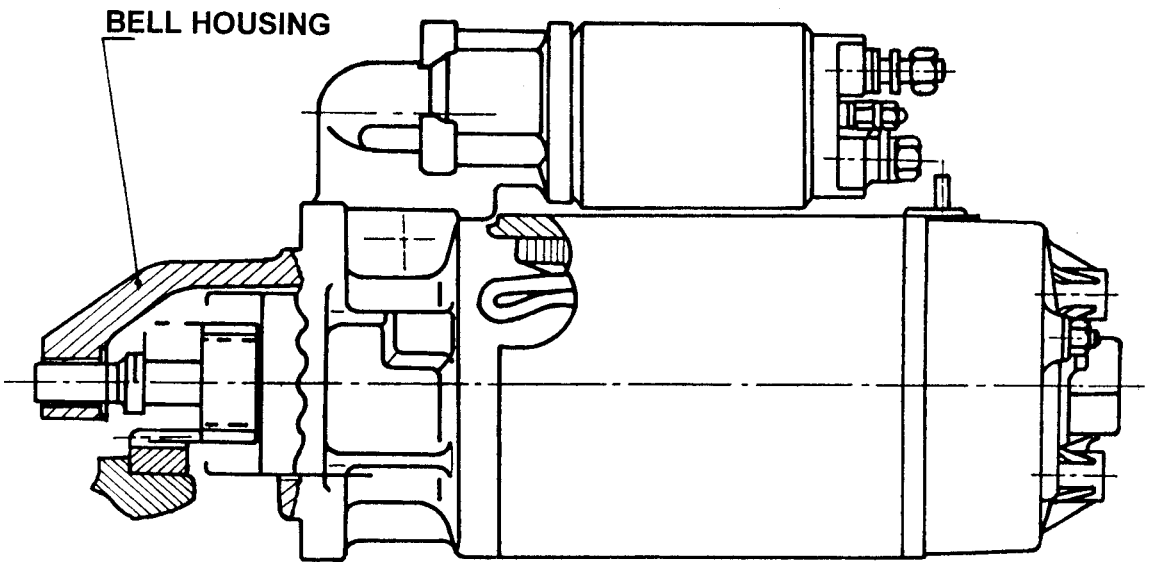


FIG. 2 BELL-HOUSING

#### 4.1.1 General Purpose Starter Motor

Inertia and pre-engaged drive starter motor on petrol/diesel/CNG/LPG engine vehicles where the starter motor is located in such a position as to be subjected only to water splash experienced on wet roads.

#### 4.1.2 Externally Protected (Water and Oil-Proof from Splash Except from Bell-housing)

Pre-engaged starter motor on petrol/diesel/CNG/LPG

engine vehicles, where the starter motor is subject to direct water splash from wheels and also in diesel applications to fuel oil drip from leaking joints and fuel oil splash during filter change and bleeding.

#### 4.1.3 Internally Protected (Oil-Sealed from Bell-housing)

Pre-engaged drive and axial type starter motors on diesel engines having oil immersed clutches where oil level is lower than the mounting position of the starter motor.

## 4.2 Operating Duty

### 4.2.1 Light Duty

Starter motors suitable basically for passenger car, light commercial vehicles fitted with petrol/LPG/CNG engines and single cylinder diesel/petrol/LPG/CNG engines.

### 4.2.2 Medium Duty

Starter motors suitable for light commercial vehicles and tractors fitted with diesel engines and CNG engine vehicles.

### 4.2.3 Heavy Duty

Starter motors suitable for heavy commercial vehicles and CNG engine vehicles.

### 4.2.4 Extra Heavy Duty

Starter motors suitable for off-highway equipment (for example, earth moving equipment) with severe operating conditions, industrial engines, construction equipment (for example, screw compressors) and special vehicles.

## 5 SELECTION OF DRIVES

### 5.1 Inertia Drive

Inertia drive is recommended only for light duty applications such as 3 wheelers fitted with single cylinder petrol/CNG/LPG engines.

There are two varieties in this type. One with drive assembly as part of the engine as shown in Fig. 3 and the other with the drive assembly as part of the starter motor itself as shown in Fig. 4.

## 5.2 Pre-engaged Drive

These types of drives are recommended for light and medium duty applications. It may also be used for heavy and extra heavy-duty applications. There are two types in pre-engaged drives, over hang pinion type (*see* Fig. 5) and open type (*see* Fig. 6).

## 5.3 Axial Type

These types of drives are recommended for heavy duty and extra heavy duty applications (*see* Fig. 7).

## 6 MARKING

**6.1** Each starter motor shall be marked or affixed with a nameplate with the following information:

- a) Name or trade-mark of starter motor manufacturer,
- b) Type number and part number,
- c) Rated voltage,
- d) Direction of rotation,
- e) Year of manufacture,
- f) Country of manufacture, and
- g) Identification for environmental compatibility.

**6.2** The terminals shall be clearly marked with, '+', 'SOL' and '-' signs.

### 6.3 BIS Certification Marking

The product may also be marked with the Standard Mark.

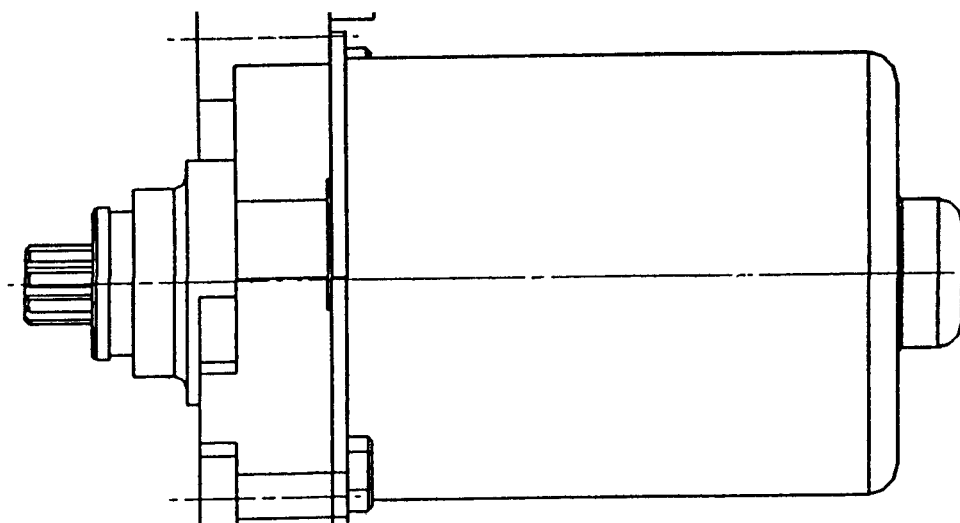


FIG. 3 STARTER MOTOR WITH DRIVE ASSEMBLY AS PART OF ENGINE



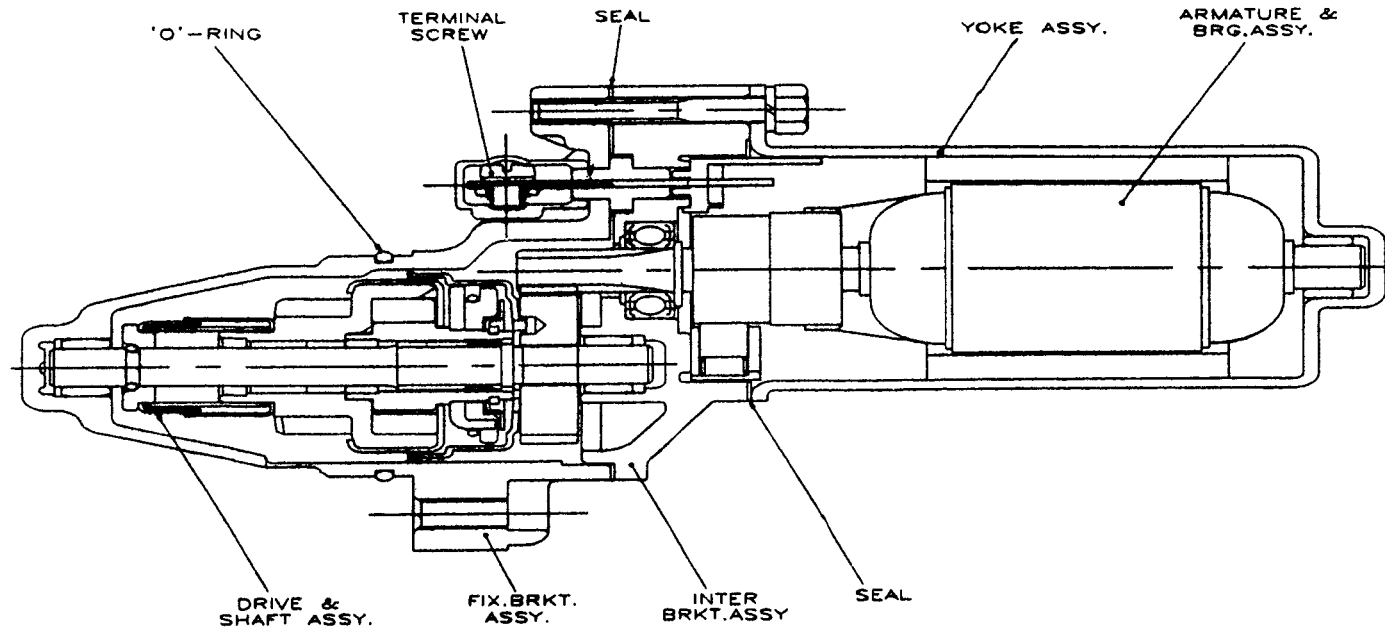


FIG. 4 STARTER MOTOR WITH DRIVE ASSEMBLY

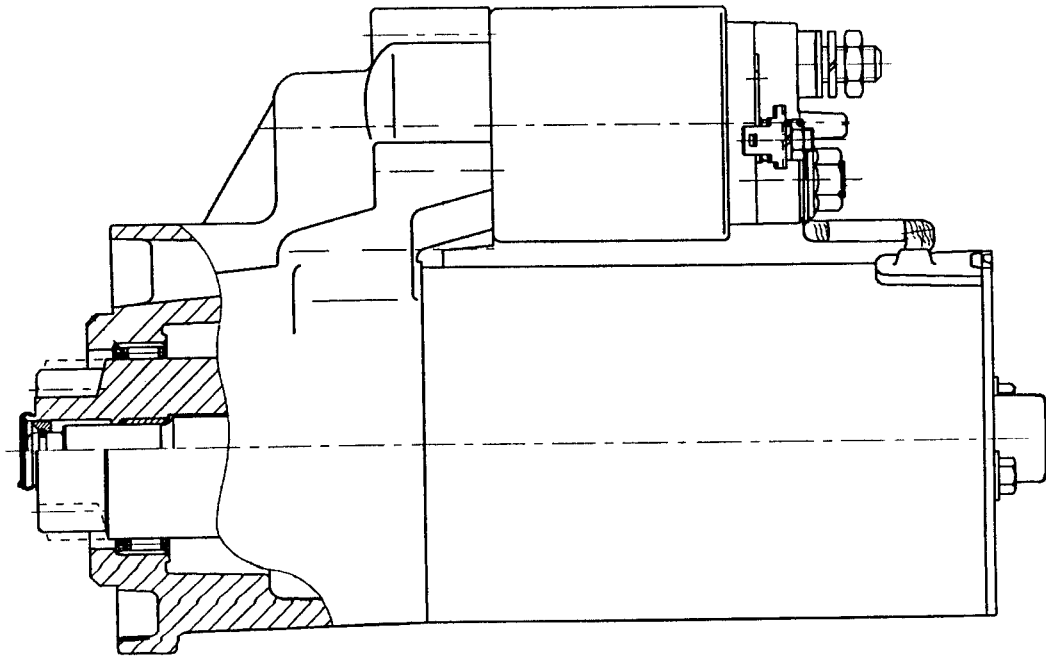
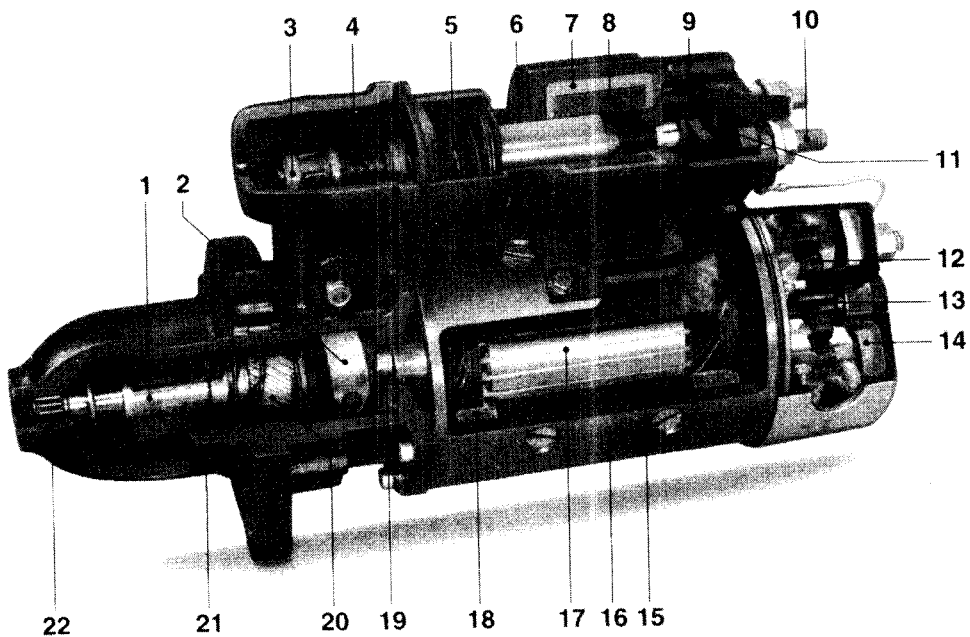
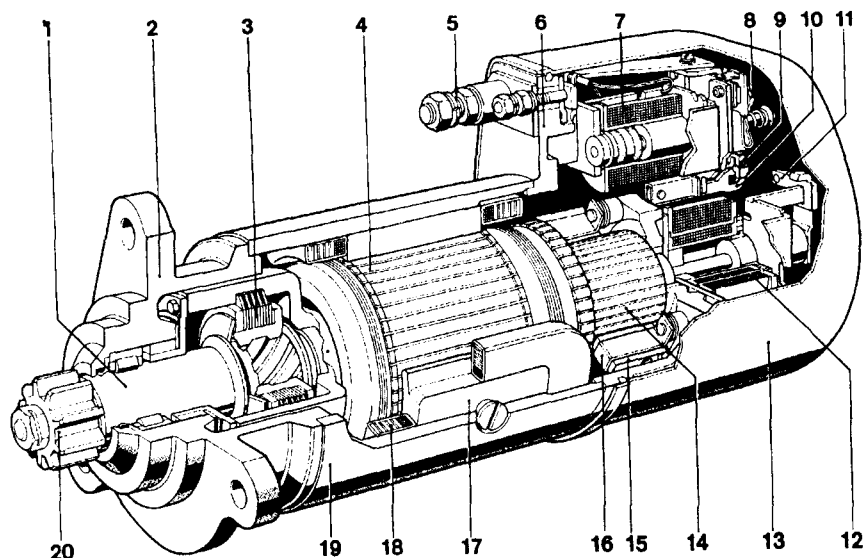


FIG. 5 OVER HANG PINION TYPE



1 — Pinion, 2 — Engaging lever, 3 — Spool, 4 — Cutoff spring, 5 — Return spring, 6 — Solenoid switch, 7 — Hold-in winding, 8 — Pull-in winding, 9 — Moving contact, 10 — Terminal, 11 — Contact, 12 — Brush spring, 13 — Commutator, 14 — Carbon brushes, 15 — Pole shoe, 16 — Field frame, 17 — Armature, 18 — Excitation winding, 19 — Brake disc, 20 — Helical spline, 21 — Meshing spring, 22 — Drive end shield.

FIG. 6 OPEN TYPE



1 — Drive spindle, 2 — Drive housing, 3 — Multiplate overrunning clutch, 4 — Armature, 5 — Terminal, 6 — Commutator and shield, 7 — Control relay, 8 — Moving contact, 9 — Stop, 10 — Tripping lever, 11 — Release lever, 12 — Engagement solenoid, 13 — End cover, 14 — Commutator, 15 — Carbon brush, 16 — Brush holder, 17 — Pole shoe 18 — Excitation winding, 19 — Field frame, 20 — Pinion.

FIG. 7 AXIAL TYPE DRIVE

**6.3.1** The use of the Standard Mark is governed by the provisions of *Bureau of Indian Standards Act, 1986* and the Rules and Regulations made thereunder. The details of conditions under which the licence for the use of Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

## 7 TESTS

### 7.0 General

Unless otherwise specified, all tests shall be carried out at an ambient temperature of 20 to 45°C.

### 7.1 Classification of Tests

#### 7.1.1 Type Tests

The following shall constitute type tests:

- a) Visual examination (*see 7.2*),
- b) Dimensional check (*see 7.3*),
- c) High voltage test (*see 7.4*),
- d) Insulation resistance test (*see 7.5*),
- e) Performance (*see 7.6*),
- f) Test for characteristic curves (*see 7.7*),
- g) Pinion engagement test (*see 7.8*),
- h) Solenoid life test (*see 7.9*),
- j) Endurance test (*see 7.10*),
- k) Continuous cranking test (*see 7.11*),
- m) Cold cranking test (optional test) (*see 7.12*),
- n) Sinusoidal vibration test (*see 7.13*),
- p) Damp heat (cycling) test (*see 7.14*),

- q) Thermal shock test (*see 7.15*),
- r) Salt spray test (*see 7.16*),
- s) Cold spray test (*see 7.17*),
- t) Hot storage test (*see 7.18*),
- u) Mud water splash test (*see 7.19*),
- v) Media resistance test with motor vehicle fuels (*see 7.20*),
- w) Dust test (*see 7.21*),
- x) Water spray test (*see 7.22*), and
- y) Test for internally protected (oil sealed) type starter motors (*see 7.23*).

#### 7.1.1.1 Criteria for approval

Nine samples shall be submitted for testing together with the relevant data. These shall be tested according to the sequence of tests given in Annex A. The testing authority shall issue a type approval certificate if the starter motors are found to comply with the requirements of tests given in 6.1.1.

**7.1.1.2** In case of failure in one or more type tests, the testing authority shall call for fresh samples not exceeding twice the number of original samples and subject them to the test(s) in which failure occurred. If in repeat test(s) no failure occurs, the tests shall be considered to have been satisfied.

#### 7.1.2 Acceptance Tests

The following shall constitute acceptance tests:

- a) Visual examination (*see 7.2*),
- b) Dimensional check (*see 7.3*),

- c) High voltage test (*see* 7.4), and
- d) Performance check (*see* 7.6).

**7.1.2.1** The number of samples for acceptance test shall be as agreed between the purchaser and the manufacturer. However, a recommended plan of sampling is given in Annex B.

### 7.1.3 Routine Tests

The following shall constitute routine tests:

- a) Visual examination (*see* 7.2), and
- b) Performance check (*see* 7.6).

## 7.2 Visual Examination

The starter motors shall be visually examined for the following:

- a) Surface condition,
- b) Free from damages,
- c) Intactness of fasteners, and
- d) Markings.

## 7.3 Dimensional Check

The starter motors shall be checked for dimensions using appropriate measuring instruments. The dimensions shall conform to that of the outline drawing mutually agreed between the customer and the supplier.

## 7.4 High Voltage Test

This test shall be carried out only on separate sub-assemblies of brush gear assembly, armature and pole-housing assembly consisting of pole-housing, excitation winding, and pole shoe. On new cleaned and dried sub-assemblies 900–990 V d.c. or 500 V a.c. r.m.s. shall be applied between conducting members and ground. The sub-assemblies shall withstand this test without arcing or puncture indicative of insulation breakdown. The repeat test is not advisable and if unavoidable, the test shall be carried out with 80 percent of the previous test voltage after cleaning and drying the sub-assemblies.

Test duration is 5s.

NOTE — Before carrying out the high voltage test, the unit under test should be cleaned and thoroughly dried. The high voltage test should be conducted with caution as repeated application of the test voltage on the same unit may injure the insulation and thereby reduce the safety factor. If for any reason it is desired to repeat the conduct additional high voltage test, the test voltage shall be reduced to 200 V a.c. r.m.s. Before applying the supplementary high voltage, the unit under test should be cleaned and thoroughly dried.

## 7.5 Insulation Resistance Test

The insulation resistance shall be measured between terminals and the external metal parts of the starter

motor using a 500 V d.c. mega-ohm meter. If any of the terminals is internally grounded, the earth connection shall be disconnected. Prior to carrying out insulation resistance measurements, it should be ensured that the windings are clean and dry. The test shall be carried out on subassemblies of starter motor.

The test duration is 5 s.

The insulation value thus measured shall not less than 0.5 MΩ.

## 7.6 Performance Check

### 7.6.1 Light Running Test

With nominal voltage supply, the starter motor shall be run up to full speed at no load. Any excessive noise due to armature rubbing on poles or due to commutator bar lift shall be checked. The speed, current and voltage shall be as per the outline drawing, mutually agreed to between the customer and the supplier.

#### 7.6.1.1 Test bench

The following type of test rig may be used. The test bench given below allows performance measurement to be taken by engaging the starter pinion with a ring gear. The backlash between the pinion and ring gear is adjusted in accordance with the starter motor manufacturers recommendations.

The test rig for the load test of starter motor shall consist of the following:

- a) A suitable braking device (for example Magnetic particle clutch) to apply load on the starter pinion,
- b) Meters for voltage, current, speed and torque measurements, and
- c) Direct current supply with means for adjusting and maintaining voltage.

#### NOTES

1 A low ripple motor generating set or transformer rectifier may be used instead of batteries in which case the permissible ripple shall not exceed 2 percent peak value.

#### 2 Measurement Accuracy

Current	: ± 1 percent
Voltage	: ± 1 percent
Speed	: ± percent
Torque	: ± percent

### 7.6.2 Locked Torque Test

#### 7.6.2.1 Procedure

The pinion gear of the starter motor shall be locked on the test rig by means of suitable application of load. Applying the voltage indicated in the drawing the current and torque shall be measured. The test duration shall be limited to 2.0 s.

7.7 Test for Characteristic Curves

7.7.1 Procedure

Run the starter motor at various discrete torque loads and record the torque, voltage, current and rotational speed at each of this discrete loads. Record enough points to develop curves. The performance characteristic curve shall be mutually agreed to between the customer and the supplier. After each measurement point cool all parts of the motor to test temperature.

In case of continuous loading method the total duration of test shall be with in 12.0 s.

Correction of torque with ring gear efficiency.

The correction shall be made using the following formula:

$$M_1 = \frac{M_2 \times Z_1}{Z_2 \eta}$$

where

- $M_1$  = corrected torque with ring gear efficiency,
- $M_2$  = measured torque,
- $Z_1$  = number of teeth on the starter motor pinion,

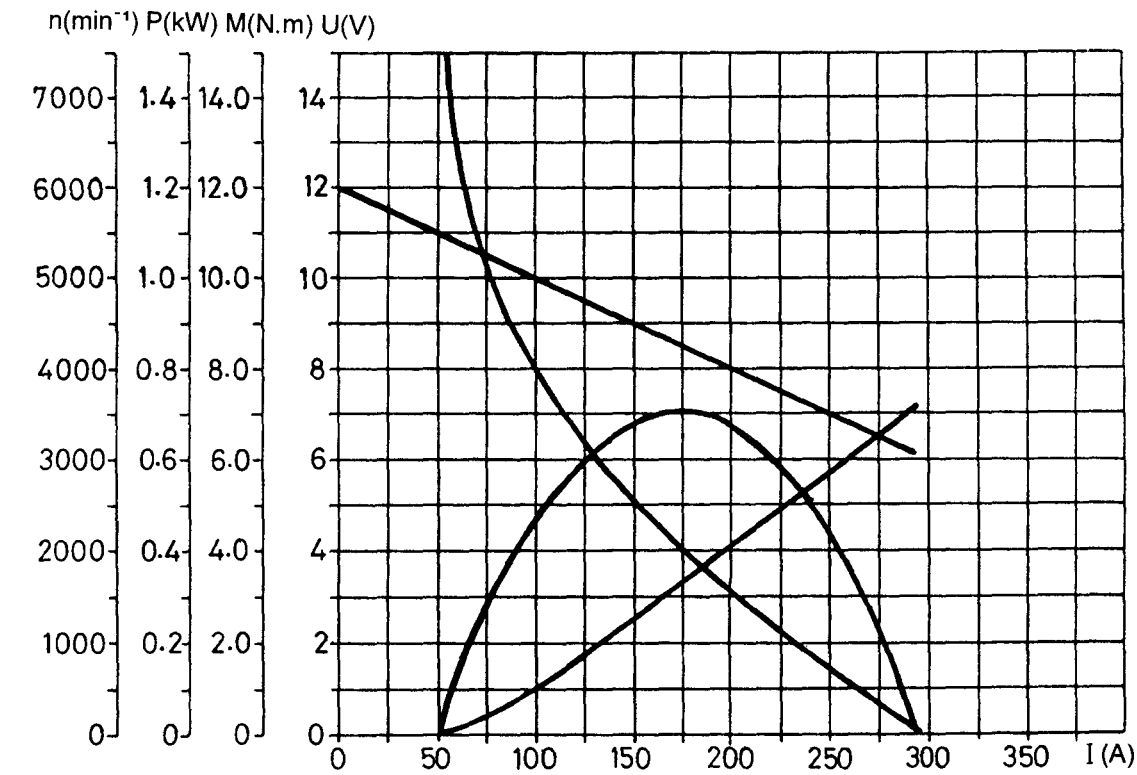
- $Z_2$  = number of teeth on the ring gear of the test rig, and
- $\eta$  = efficiency of the mating gears.

A suitable method for calculating the performance characteristics of starter motors for different conditions of battery voltages and temperatures from the given condition is given in Annex C.

The typical performance curve is shown in Fig. 8.

7.8 Pinion Engagement Test

- a) *Inertia starter* — The pinion shall travel to its full engagement till stop when the starter motor is connected to 10 V supply for starters for 12 V systems without any interruption during travel.
- b) *Pre-engaged starter* — Distance between the ring gear and starter pinion (in static condition) shall be maintained to minimum value as specified in the outline drawing, mutually agreed to between the customer and the supplier. On application of more than 8 V at ambient to solenoid terminal (terminal 50) the contacts shall close and the pinion shall move forward.



V – Voltage in volts  
P – Power in kW  
n – Speed in rpm  
I – Current in amps  
M – Torque in Nm

FIG. 8 TYPICAL PERFORMANCE CURVES

Measuring duration 2s.

- c) *Axial type starter* — The armature shall travel to its full engagement stop when the starter motor is connected to 10 V or 20 V for starter motors for 12 V and 24 V systems respectively without any interruption during travel.

## 7.9 Solenoid Life Test

Distance between the ring gear and starter motor pinion (in static condition) shall be maintained to minimum value as specified in the outline drawing. The solenoid of the starter motor alone to be energized. The contact of solenoid is made to carry a current equal to the peak power in corresponding battery. The solenoid is energized for 1 s. During the energization, the moving contact shall be allowed to draw corresponding cranking current of that application. The solenoid off time is decided by the solenoid cooling. Maximum temperature allowed shall be 100°C. A total of 50 000 cycles shall be conducted.

At the end of the test the solenoid shall be functional and solenoid contact shall carry the set current. There shall be no damage to the solenoid.

## 7.10 Endurance Test

**7.10.1** The set-up for the test shall consist of the following:

- a) *Engine* — Capacity and number of cylinders of the engine shall be as in the vehicle installation. The same make and type of engine for which the starter motor is specified shall be preferable for the test.
- b) *Battery* — The capacity and type of the battery shall be similar to the one specified for the vehicle and it shall be maintained at not less than 75 percent fully charged condition.

**7.10.2** The following initial measurements on starter motor shall be conducted before doing the testing:

- a) Pinion static position,
- b) Condition of pinion (visual), and
- c) Starter motor performance as per outline drawing.

## 7.10.3 Test Conditions

- a) A new flywheel ring gear shall be fitted on the engine. The ring gear dimensions, profile, tooth chamfer, material and hardness shall be mutually agreed upon by the customer and the supplier.
- b) The starter motor main and solenoid circuit resistance shall not exceed the values specified by the supplier. The starter motor and solenoid terminal voltages shall not be lower than the value specified in the outline drawing mutually agreed by the customer and the supplier.
- c) During the test, the starter motor pole housing temperature shall not exceed 60°C. This decides the test cycle time and therefore the rest period for the starter motor. Fan cooling to the pole housing shall be permitted to reduce the cycle time.
- d) The battery charging circuit shall be disconnected while the starter motor is energized. The charging system shall be so selected that the battery is kept 75 percent charged condition throughout the test.
- e) The throttle shall be set to give an engine speed as recommended by the customer.

## 7.10.4 Test Cycle

The test cycle for endurance test for different type of starter motors shall be as given below:

Type of Starter Motor	Starter Motor Energized Period without Ignition/Fuel	Starter Motor Energized Period with Ignition/Fuel	Total Starter Motor Energized Period	Total Ignition/Fuel on Period, Min	No. of Starts	Servicing
(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Second	Second	Second	Second		
Light duty	0.5	0.5	1	2	30 000	Drive (Inertia type) pinion brush and shaft (pre-engaged type) shall be lubricated after each 5 000 starts. Bush change shall be permissible after 15 000 starts

Type of Starter Motor	Starter Motor Energized Period without Ignition/Fuel	Starter Motor Energized Period with Ignition/Fuel	Total Starter Motor Energized Period	Total Ignition/Fuel on Period, Min	No. of Starts	Servicing
(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Second	Second	Second	Second		
Medium duty	0.5	1	1½	2	40 000	a) Pinion and drive end bracket bearing bushes and shaft helix shall be lubricated after each 5 000 starts b) Brush change shall be permissible after 20 000 starts
Heavy duty	5	1	6	3	10 000	a) Pinion and drive end bracket bearing bushes and shaft helix shall be lubricated after each 5 000 starts b) Brush change shall be permissible after 5 000 starts
Extra heavy duty	7	1	8	3	6 000	a) The plate type clutch shall be checked and reset after 1 000 starts b) Pinion and drive end bracket bearing bushes and shaft helix shall be lubricated after 3 000 starts c) Brush change shall be permissible after 3 000 starts

7.10.5 Requirement

The starter motor shall complete the specified number of starts without failure. After this test the starter motor shall be functional.

7.11 Continuous Cranking Test

7.11.1 Test Equipment

The set-up for the test shall consists of the following:

- a) *Engine* — Capacity and type of engine shall be as in the vehicle installation. Grade of oil used shall be as recommended by the customer.
- b) *Battery* — The battery shall be of the type and capacity specified for the vehicle and maintained at fully charged condition.

7.11.2 Test Condition

- a) Starter motor main and solenoid cable resistance shall be within the values recommended by the supplier.
- b) Ignition/fuel shall be switched ‘Off’ throughout the test.

7.11.3 Procedure

The starter motor shall crank the engine continuously for a period of 5 min.

After the test, the starter motor shall not show any sign of damage due to excessive temperature raise and shall be able to crank and start the engine with fuel/ignition.

7.12 Cold Cranking Test

The engine, battery, starter motor and cables shall be soaked at the temperature (0°C or any other sub-zero temperature as agreed to between the supplier and the customer) for a period of minimum 16 h, the test to be carried out normally at 80 percent charged condition unless otherwise specified by the customer. Oil used shall be as per the recommendation by the customer. The starter motor (without ignition fuel) shall deliver the minimum cranking speed as agreed upon by the customer and the supplier.

Test duration: 30s.

### 7.13 Sinusoidal Vibration Test

Prior to the vibration test, starter motor shall be subjected to thermal shock test as per 7.15. The starter motor shall be subjected to a vibration level of 300 g for 100 h. The starter motor shall be subjected to a vibration level of 75m/s<sup>2</sup> for a period of 4 h in each direction. During the test the sweep frequency to be 100 000 c/s. After the test the starter motor shall show no damage and shall be functional.

### 7.14 Damp Heat (Cycling) Test

The test shall be conducted as specified in IS 9000 (Part 5/Sec 2). The number of conditioning cycles shall be 21. The opening portion of the starter motor shall be kept sealed throughout the test.

After this test the starter motor shall meet the requirements of light running test and lock torque test.

### 7.15 Thermal Shock Test

The starter motor shall be subjected to the following thermal shock test:

Temperature	: -20°C and +110°C
Test duration	: 30 cycles

Starter motor is kept without power supply. Soaking duration at each temperature limit shall be approximately 3 h. After the test the starter motor shall show no damage and shall be functional.

### 7.16 Salt Spray Test

The starter motor shall be mounted on the test table as in actual usage orientation. No power supplies to starter motor during testing. Salt spray solution containing 5 percent sodium chloride shall be sprayed continuously on to the sample.

Temperature	: 35 ± 2°C
Duration	: 72 h

After the test the starter motor shall be functional.

### 7.17 Cold Storage Test

Store the starter motor at -40°C for 50 h. After the test there shall be no damage to any components of the starter motor and it shall be functional.

### 7.18 Hot Storage Test

Store the starter motor at +110°C for 50 h. After the test there shall be no damage to any of the starter motor components and it shall be functional.

### 7.19 Mud Water Splash Test

The starter motor shall be mounted on the test chamber as in actual usage condition. The chamber shall be filled

with mud water. The starter motor openings are to be closed. The starter motor is subjected to a mud water splash for 4 s duration with 4 min pause. During this pause period the starter motor is energized for light run for 10 s. Totally 300 cycles are to be conducted.

After the test there shall be no damage to the starter motor or any other component of it and it shall be functional.

### 7.20 Media Resistance Test with Motor Vehicle Fuels

#### 7.20.1 Test Method

In a test cycle, the starter motor is soaked with test fluid and stored under enhanced ambient temperature.

#### 7.20.2 Test Equipment

For wetting with test fluid, following equipment is required based on the need.

- Scooping container for dipping,
- Spray gun,
- Brush,
- Forced exhaust for exhausting vapours dangerous to health, and
- Explosion proof thermal cabinet.

#### 7.20.3 Test Conditions

Designation and type of test fluids

- Window screen cleaner;
- Engine cooling fluid;
- Engine oil;
- Cold cleaning medium;
- Diesel;
- Gear box oil (manual gear box);
- ATF-Oil (automatic and steering aid);
- Rear axle oil;
- Protective grease;
- Wax remover;
- Brake fluid;
- Battery acid; and
- Petrol.

#### 7.20.4 Test Cycles

The test is carried out in cycles, where duration of one test cycle is 24 h. During the test cycle, the starter motor is handled in general as follows:

- wet for 5 s with test fluid and there after, and
- store for 24 h in thermal cabinet at 80°C. A different temperature can be mutually agreed.

The above procedure should be repeated for each of the test fluids mentioned above.

Number of test cycles as agreed.



7.20.5 Evaluation

After the test — including a generation phase to be agreed — there shall be no deformation, discoloration, formation of crack and it shall be functional.

7.21 Dust Test

This test is a passive test as shown in Fig. 9.

7.21.1 Test Instructions

The starter motor under test is brought into the test chamber, fixed and is exposed in a horizontal air-current generated from outside in its ready-condition. The air-current carries with it dust particles.

7.21.2 Test Dust

The mixture of dust contains the following two constituents:

50 percent by weight unburnt — Portland cement + 50 percent by weight flue-dust.

The mixture is passed through a sieve a mesh-width 0.25 mm.

The grain size distribution shall be approximately as follows:

- 33 percent by weight : < 0.032 mm
- 76 percent by weight : > 0.032 < 0.250 mm

when the dust is contaminated very much by rubbing from the starter motor, the dust is to be renewed.

7.21.3 Test Temperature

The test temperature shall be between +20°C and +70°C.

7.21.4 Air-Humidity

The relative air-humidity shall be for an ambient temperature of 23°C below 60 percent.

7.21.5 Density of Dust

The density of dust shall be  $5 \pm 2 \text{ g/m}^3$  at a distance of 10 cm before the starter motor.

7.21.6 Velocity of Air-Current

The velocity of air-current shall be adjustable between 1.5 to 3 m/s.

7.21.7 Duration of Test

- a) 2 h for starter motors used in passenger cars, commercial vehicles, Omni buses and automobiles where similar stresses are experienced.
- b) 4 h for starter motors used in tractors, harvesters and prime movers.

7.21.8 Post-treatment

At the end of test duration, the starter motor is kept in the test device, till the dust settles down completely. If required, it may be kept at temperatures between +20°C and +23°C till stability of temperatures is achieved.

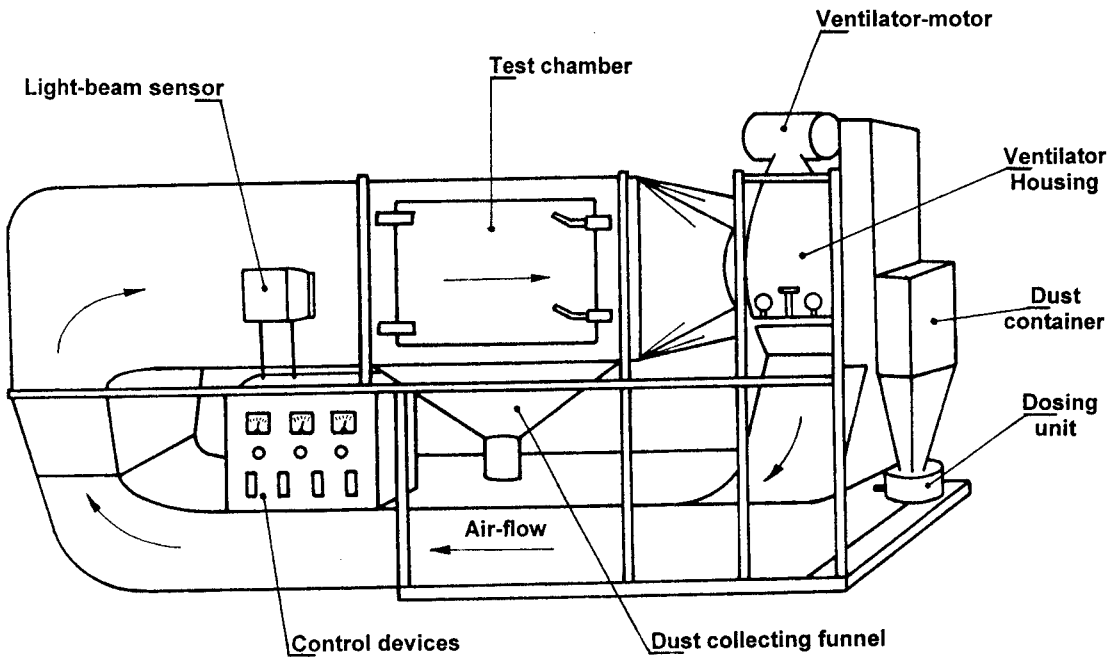


FIG. 9 SCHEMATIC DIAGRAM SHOWING THE TEST EQUIPMENT

### 7.21.9 Evaluation

After the test the starter motor shall be functional.

## 7.22 Water Spray Test

### 7.22.1 Test Equipment

The dripping device shall be capable of spraying water under laboratory atmospheric conditions at a static pressure of  $200 \text{ kPa} \pm 15$  percent from 8 shower heads with the following:

- The static pressure shall be measured nearest to each shower head, and
- The water used for this test may be re-circulated.

It shall be possible to direct the spray from 4 of these shower heads downwards, at an angle of  $45^\circ$ , at each of the four uppermost corners of the item under test and from the remaining 4 shower heads, horizontally at the center of the area of each of four sides of the item. It shall also be possible to locate the shower heads at a distance of 0.5 m to 0.75 m from the corners of sides of the item.

The construction of shower head assembly and details of its parts are given in Fig. 10.

- The sketch shown in Fig. 11 represents the spray which made out of brass and the tolerance for the dimensions shall be  $\pm 0.15$  with chamfered edges.
- Figure 12 represents the nut and it is also made out of brass. The tolerance shall be  $\pm 0.15$  and the edges should be smooth.
- Figure 13 represents the filter part of the shower assembly. It is made out of 1 mm cold rolled brass sheet perforated 0.8 diameter holes on staggered pitches 1.5 approximately.

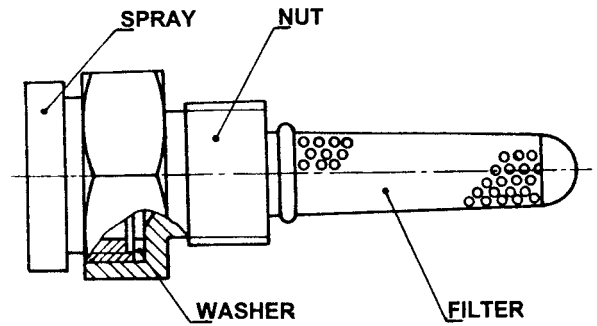


FIG. 10 SHOWER HEAD ASSEMBLY

Figure 14 represents the washer of the shower assembly. It is made out of leather.

### 7.22.2 Test Condition

Starter motor shall be mounted on the rotary table as in actual usage orientation. Spray from the shower heads shall be directed as given in one of the three test conditions as agreed between the supplier and the customer. No power supply to starter motor during testing.

- Condition 1* — Spray from four heads shall be directed at an angle  $45^\circ$  at each of the four uppermost corners of the item.
- Condition 2* — Spray from four shower heads shall be directed horizontally at the centre of the each of the four sides of the equipment.
- Condition 3* — Spray from eight showers four of them being directed horizontally at the centre of the area of each of the four sides of the item.

After the test, the starter motor shall be dried by applying a blast of air at room temperature.

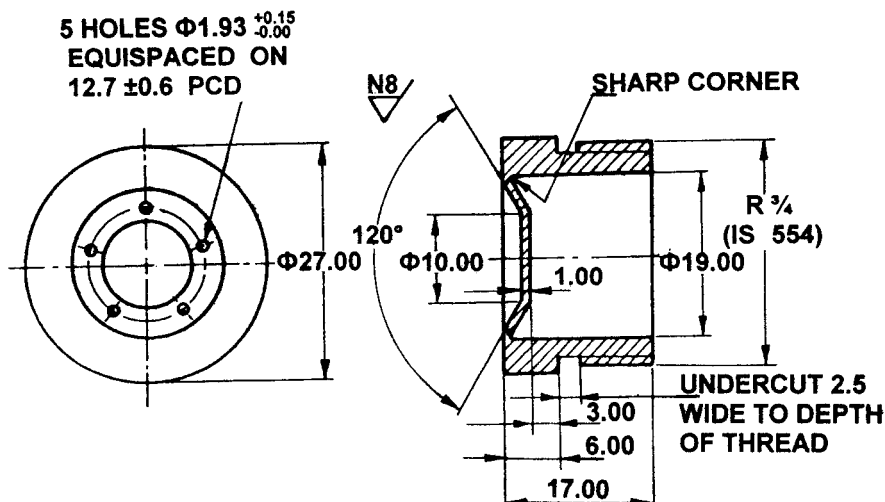


FIG. 11 SPRAY FOR SHOWER HEAD ASSEMBLY

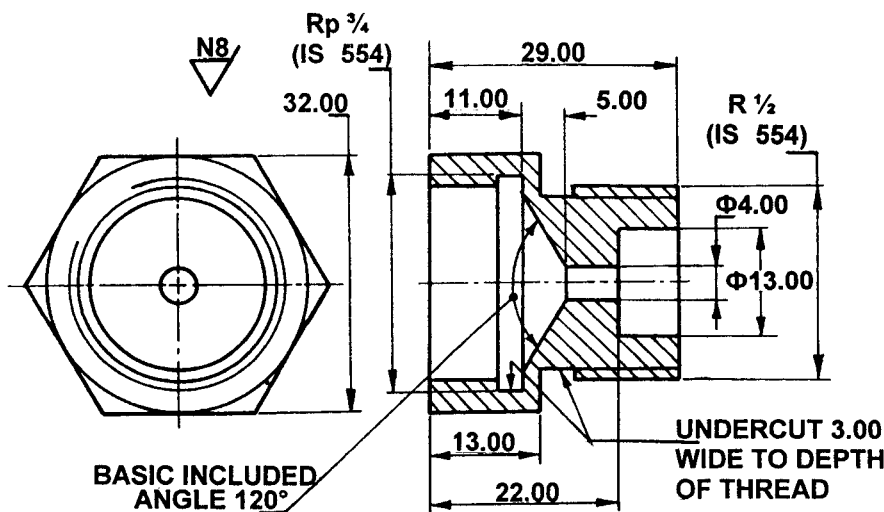


FIG. 12 NUT FOR SHOWER HEAD ASSEMBLY

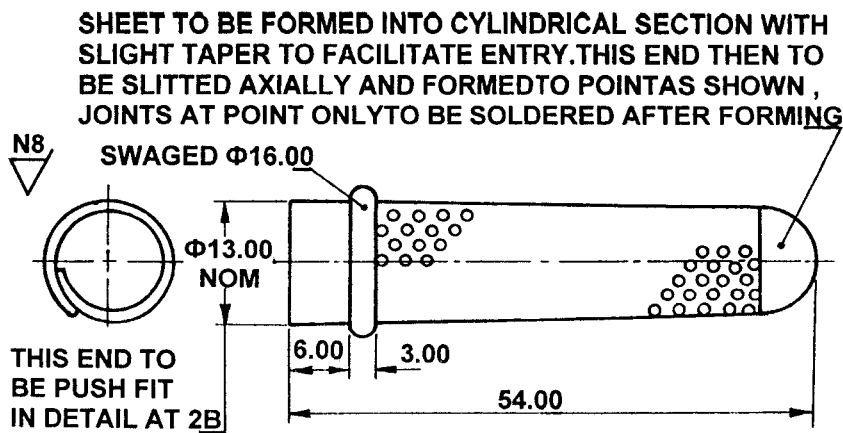


FIG. 13 FILTER FOR SHOWER HEAD ASSEMBLY

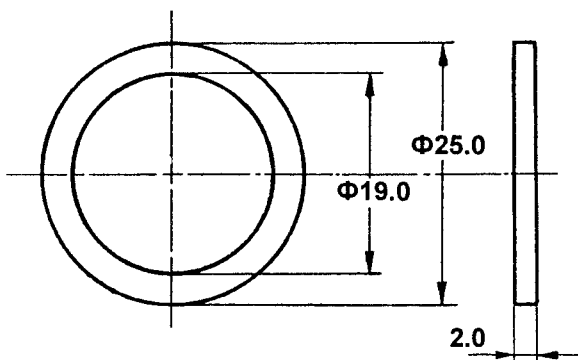


FIG. 14 WASHER FOR SHOWER HEAD ASSEMBLY

7.22.3 Evaluation

There shall be no damage to the components of the starter motor and it shall be functional after the test.

7.23 Test for Internally Protected (Oil-Sealed) Type Starter Motors

The testing method and test fixture for this test depend on the design of the starter motor.

- a) *Step 1:* Seal the opening of the starter motor drive end flange side. Pass the air through the commutator end cover side.  
  
Air pressure : 50 kPa (0.5 bar), *Min*  
Test duration : 5 s  
Air leakage : 0.5 kPa (0.005 bar), *Max* (pressure drop)
- b) *Step 2:* Seal the front opening of the starter and pass air through the drive end flange side  
  
Air pressure : 50 kPa (0.5 bar), *Min*  
Test duration : 5 s  
Air leakage : 0.5 kPa (0.005 bar), (pressure drop) *Max*

## ANNEX A

(Clause 7.1.1.1)

## SAMPLING PLAN FOR TESTING

The table below indicates the test plan matrix and actual number of samples to be tested can be mutually agreed between the manufacturer and supplier.

Sl No.	Clause No.	Characteristic Test	No. of Samples																	
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
i)	7.2	Visual examination	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
ii)	7.3	Dimensional check	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
iii)	7.4	High voltage test	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
iv)	7.5	Insulation resistance test	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
v)	7.6	Performance check	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
vi)	7.7	Characteristic curves test	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
vii)	7.8	Pinion engagement test	x	x																
viii)	7.9	Solenoid life test			x	x														
ix)	7.10	Endurance test					x	x	x											
x)	7.11	Continuous cranking test								x										
xi)	7.12	Cold cranking test									x									
xii)	7.13	Sinusoidal vibration test										x								
xiii)	7.14	Damp heat test											x							
xiv)	7.15	Thermal shock test												x						
xv)	7.16	Salt spray test													x					
xvi)	7.17	Cold storage test														x				
xvii)	7.18	Hot storage test															x			
xviii)	7.19	Mud water splash test																x		
xix)	7.20	Media resistance test																	x	
xx)	7.21	Dust test																		x
xxi)	7.22	Water spray test																		x
xxii)	7.23	Internally water protection test																		x

ANNEX B  
(Clause 7.1.2.1)

RECOMMENDED SAMPLING SCHEME AND CRITERIA FOR ACCEPTANCE

B-0 GENERAL

**B-0.1** If statistical quality control techniques have been used for production control such test results and relevant chart may be made available along with the material supplied to enable the purchaser to judge the acceptability or otherwise of a lot. In case such information is not available, the following procedure is recommended for judging conformity of a lot to the requirements of this specification.

B-1 SCALE OF SAMPLING

B-1.1 Lot

In a consignment all the starter motors of the type and rating manufactured from the same material under similar conditions of production shall be grouped together to constitute a lot.

**B-1.2** The number of starter motors to be selected from each lot shall depend upon the lot size and shall be in accordance with col 2 and col 3 of Table 1.

**B-1.3** The starter motor shall be selected from the lot at random. In order to ensure randomness of selection, procedure given in IS 4905 may be followed.

Table 1 Sample Size and Criteria for Conformity  
(Clause B-1.2 and B-2.1)

Sl No. (1)	Lot Size (2)	Sample Size (3)	Permissible No. of Defectives (4)
i)	Up to 150	13	0
ii)	151–300	20	0
iii)	301–500	32	0
iv)	501–1 000	50	1
v)	1 001 and above	80	2

B-2 NUMBER OF TESTS AND CRITERIA FOR CONFORMITY

**B-2.1** All the starter motor selected at random in accordance with col 2 and col 3 of Table 1 shall be subjected to the acceptance tests. The starter motor failing to satisfy any of the acceptance tests shall be termed defective.

A lot shall be considered as conforming to the requirements of acceptance tests if the number of defectives found in the sample is less than or equal to the corresponding acceptance number given in col 4 of Table 1; otherwise the lot shall be rejected.

ANNEX C  
(Clause 7.7.1)

METHOD OF CALCULATING PERFORMANCE CHARACTERISTICS OF STARTER MOTORS FOR DIFFERENT CONDITIONS OF BATTERY VOLTAGES AND TEMPERATURES, FROM THE GIVEN CONDITIONS

C-1 CHANGE IN BATTERY VOLTAGE

**C-1.1** Let the new battery characteristics be  $A_1$  (see Fig. 15). At a given current  $Z$  the starter motor characteristics are as follows:

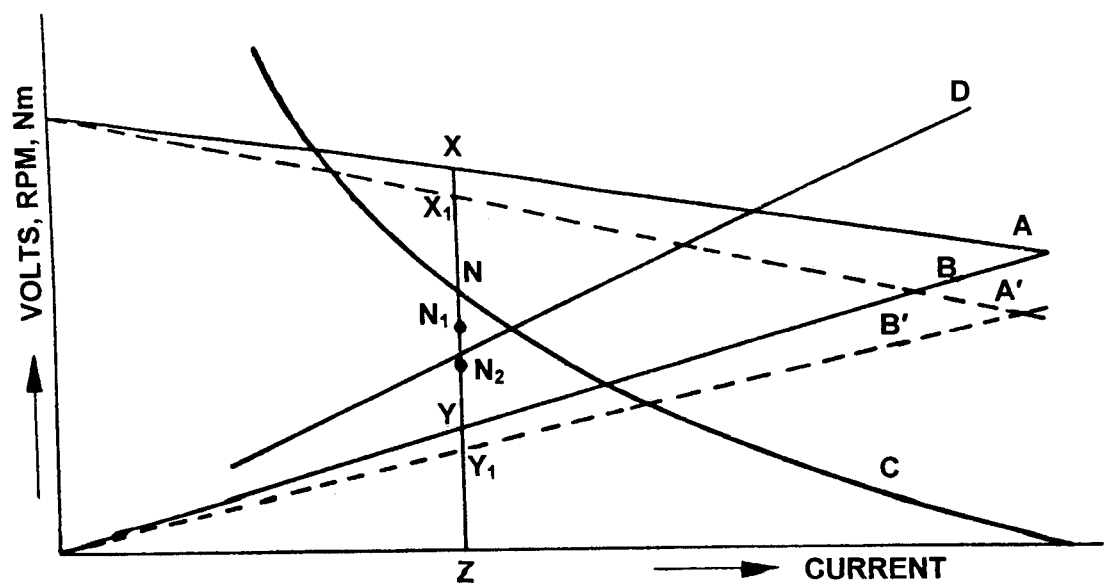
- Starter motor terminal voltage :  $XZ$
- Starter motor internal drop :  $YZ$
- Starter motor speed :  $NZ$

The starter terminal voltage changes to  $X_1 Z$  with the new battery.

Then the new speed will be:  $\frac{X_1 Z - YZ}{XZ - YZ} \times NZ = N_1 Z$

This is based on the principle that the speed of a series motor is proportional to the back electromotive force.

**C-1.2** The new speed for different values of current may be calculated based on the above method and the new speed curve for the new battery characteristics may be obtained.



- A = battery voltage characteristics (Starter  
Terminal Volts – Current)

B = machine resistance (Stall Volts – Current)
- C = speed (rev/min – Current)

D = torque (Nm – Current)

FIG. 15 CHARACTERISTIC CURVE

C-2 CHANGE IN AMBIENT TEMPERATURE

C-2.1 The battery performance characteristics and the starter motor resistance changes with the change in ambient temperature.

If the battery performance changes to A' and the machine resistance changes to B', the change in speed is:

$$\frac{X_1 Z - Y_1 Z}{XZ - YZ} \times NZ = N_2 Z$$

C-2.2 The new speed for different values of current may be calculated based on the above method and the new speed curve may be obtained.

NOTE — The torque-current characteristics is not affected by the change in battery temperature.

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